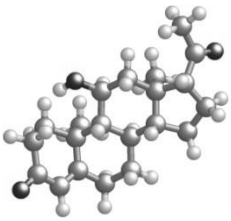

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Date: …… **/** …… **/** ……

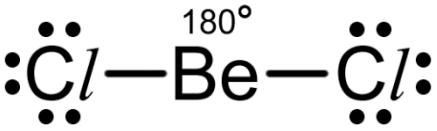
Valence Shell Electron Pair Repulsion Theory (VSEPRT)

Opposite charges attract, and similar charges repel. As a consequence, a pair of negatively charged electrons in the valence shell of an atom will repel other pairs of negatively charged electrons in the valence shell of the same atom. The pairs of electrons may be bonding (*i.e.* a shared pair of electrons forming a covalent bond between two atoms) or non-bonding (*i.e.* a lone pair of electrons in the valence shell of an atom). *Electrostatic forces of repulsion* cause pairs of electrons in the valence shell of an atom to arrange themselves *as far apart from each other as possible in three-dimensions*. The resulting arrangement of *all* pairs of electrons in the valence shell of the atom gives each covalent molecule a particular shape.

Beryllium chloride – $BeCl_2$

- Beryllium (Group 2) has *two bonding pairs of electrons*, and *zero lone pairs of electrons* in its valence shell. Electrostatic forces of repulsion between the two bonding pairs of electrons causes them to be arranged as far apart as possible, on opposite sides of the beryllium atom. $BeCl_2$ is described as a *linear* molecule. The bond angle is 180°.

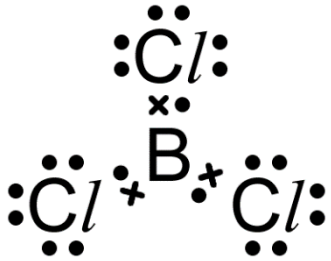
Dot-and-cross diagram of $BeCl_2$



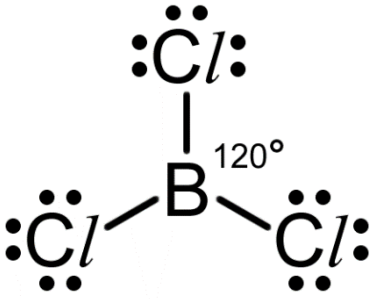
Lewis diagram of $BeCl_2$

Boron trichloride – BCl_3

- Boron (Group 13) has *three bonding pairs of electrons* and *zero lone pairs of electrons* in its valence shell. Electrostatic forces of repulsion between the three bonding pairs of electrons causes them to be arranged as far apart as possible in a triangular arrangement. BCl_3 is described as a *trigonal planar* molecule. The bond angles are 120°.



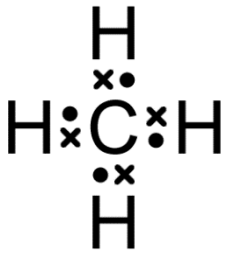
Dot-and-cross diagram of BCl_3



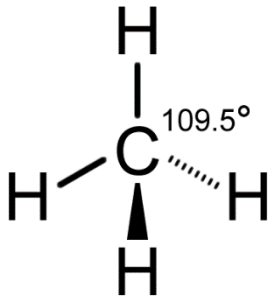
Lewis diagram of BCl_3

Methane – CH_4

• Carbon (Group 14) has *four bonding pairs of electrons* and *zero lone pairs of electrons* in its valence shell. Electrostatic forces of repulsion between the four bonding pairs of electrons causes them to be arranged as far apart as possible in a tetrahedral arrangement. CH_4 is described as a *tetrahedral* molecule. The bond angles are 109.5°.



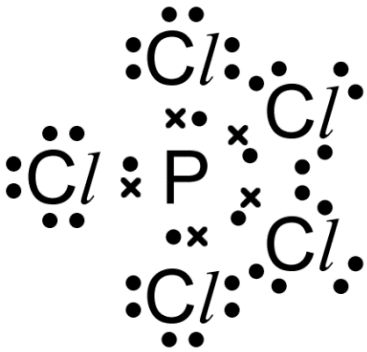
Dot-and-cross diagram of CH_4



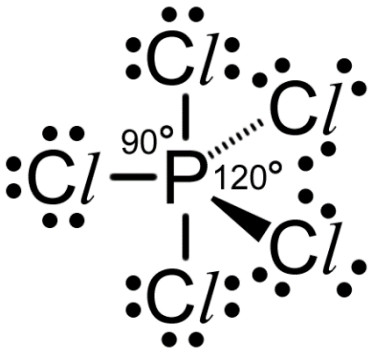
Lewis diagram of CH_4

Phosphorus(V) Chloride – PCl_5

• Phosphorus (Group 15) has *five bonding pairs of electrons* and *zero lone pairs of electrons* in its valence shell. Electrostatic forces of repulsion between the five bonding pairs of electrons causes them to be arranged as far apart as possible in a trigonal bipyramidal arrangement. PCl_5 is described as a *trigonal bipyramidal* molecule. The bond angles are 90° and 120°. **Note:** In this molecule, phosphorus has an *extended octet electronic configuration* with 10 electrons in its valence shell.



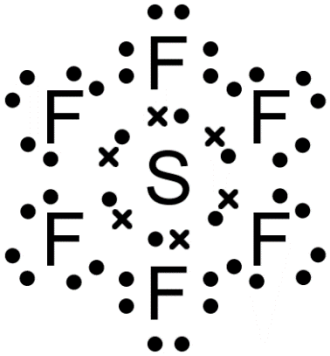
Dot-and-cross diagram of PCl_5



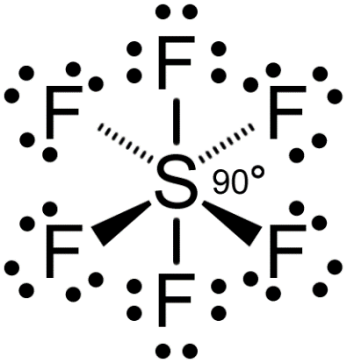
Lewis diagram of PCl_5

Sulfur(VI) Fluoride – SF_6

• Sulfur (Group 16) has *six bonding pairs of electrons* and *zero lone pairs of electrons* in its valence shell. Electrostatic forces of repulsion between the six bonding pairs of electrons causes them to be arranged as far apart as possible in an octahedral arrangement. SF_6 is described as an *octahedral* molecule. The bond angles are 90°. **Note:** In this molecule, sulfur has an *extended octet electronic configuration* with 12 electrons in its valence shell.



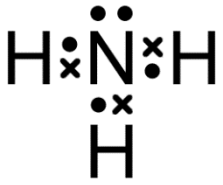
Dot-and-cross diagram of SF_6



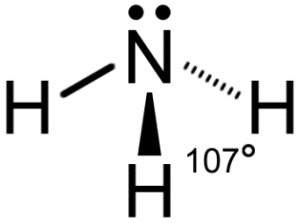
Lewis diagram of SF_6

Ammonia – NH_3

• Nitrogen (Group 15) has *three bonding pairs of electrons* and *one lone pair of electrons* in its valence shell. Electrostatic forces of repulsion between the four bonding pairs of electrons causes them to be arranged as far apart as possible in a tetrahedral arrangement. NH_3 is described as a *trigonal pyramidal* molecule. The bond angles are 107°.



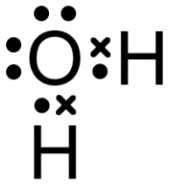
Dot-and-cross diagram of NH_3



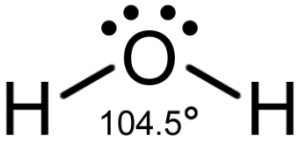
Lewis diagram of NH_3

Water – H_2O

• Oxygen (Group 16) has *two bonding pairs of electrons* and *two lone pairs of electrons* in its valence shell. Electrostatic forces of repulsion between the four bonding pairs of electrons causes them to be arranged as far apart as possible in a tetrahedral arrangement. H_2O is described as an *angular* molecule. The bond angle is 104.5°.



Dot-and-cross diagram of H_2O

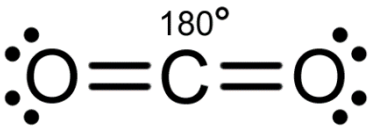


Lewis diagram of H_2O

Carbon Dioxide – CO_2

• Carbon (Group 14) has *four bonding pairs of electrons* and *zero lone pairs of electrons* in its valence shell. *Two* of the bonding pairs of electrons are in *sigma-bonds* (σ-bonds), and *two* of the bonding pairs of electrons are in *pi-bonds* (π-bonds). One sigma-bond and one pi-bond combine together to produce a double covalent bond between the carbon atom and each one of the two oxygen atoms. Electrostatic forces of repulsion between electrons of the two double covalent bonds causes them to be arranged as far apart as possible, on opposite sides of the carbon atom. CO_2 is described as a *linear* molecule. The bond angle is 180°.

Dot-and-cross diagram of CO_2



Lewis diagram of H_2O

Notes:

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Questions

1. **a)** Draw the dot-and-cross diagram of SiH_4.

b) From the dot-and-cross diagram, deduce the Lewis diagram of SiH_4.

c) Describe the shape of the shape of the SiH_4 molecule.

2. **a)** Draw the dot-and-cross diagram of PH_3.

b) From the dot-and-cross diagram, deduce the Lewis diagram of PH_3.

c) Describe the shape of the PH_3 molecule.

3. **a)** Draw the dot-and-cross diagram of SCl_2.

b) From the dot-and-cross diagram, deduce the Lewis diagram of SCl_2.

c) Describe the shape of the SCl_2 molecule.

- Scan the QR code given below to view the answers to this assignment.

http://www.chemist.sg/chemical_bonding/notes_chemical_bonding/vseprt_ans.pdf